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Soil Survey

of

The Gila Bend Area, Arizona

By

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Bureau of Chemistry and Soils

In cooperation with the
University of Arizona Agricultural Experiment Station

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SOIL SURVEY

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CONTENTS

SOIL SURVEY OF THE GILA BEND AREA, ARIZONA

By F. O. YOUNGS, in Charge, W. G. HARPER, and T. W. GLASSEY, United States Department of Agriculture, and M. R. ISAACSON, University of Arizona

AREA SURVEYED

The Gila Bend area is in the southwestern part of Maricopa County, in southwestern Arizona. (Fig. 1.) The town of Gila Bend, which is centrally located in the area, is about 120 miles east of Yuma and 80 miles southwest of Phoenix. The area occupies a long irregular strip of land lying along and bounded in part by Gila River. The Painted Rock Mountains form the extreme western boundary. In places the boundaries coincide with irrigation canals and the boundaries of irrigation districts lying within the area, and in other places arbitrary boundaries were drawn to include the irrigable land. The area comprises 224 square miles, or 143,360 acres.

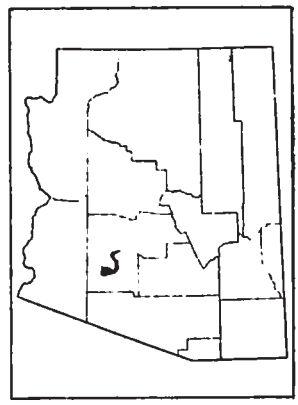

FIGURE 1.—Sketch map showing location of the Gila Bend area, Arizona

The surface relief of this part of southern Arizona is characterized by small isolated ranges of low but rugged mountains, consisting largely of bare rock, and much larger surrounding areas of valley lands. The mountain ranges, which are narrow, are mostly roughly parallel and have a general northwest and southeast trend. The intervening valleys consist largely of alluvial fans which spread out from the mountains, sloping downward at first steeply then more gently until they flatten out as they meet and merge with fans sloping down from opposite mountains. Down the alluvial fans and across the floorlike areas where they merge, shallow drainage channels have been cut, locally called desert washes or arroyos. These arroyos are tributary to Gila River which has cut a narrow and very shallow alluvial valley or flood plain through the alluvial fans. Gila River traverses the area surveyed for a distance of more than 50 miles, forming a great **S** bend from which the town of Gila Bend has taken its name. The area surveyed includes the narrow flood plain of Gila River, narrow bordering strips of uneven ridgy and dissected alluvial-fan upland, and a broad expanse of smooth gently sloping alluvial fans farther back from the river around Smurr, Theba, and Piedra in the southwestern part of the area. Very little of the mountain land is included in the area surveyed. The general location of the mountains is shown by names printed along the borders of the map.

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The elevation at Gila Bend is 737 feet, and this is probably about the average elevation for the area. The highest elevation is reached in the Painted Rock Mountains, which rise several hundred feet higher than Gila Bend, and the lowest is at the point where Gila River leaves the area at the northwest corner.

The Gila Bend area is sparsely settled. A number of ranches scattered along Gila River were taken up in the seventies, eighties, and nineties, and the land was cleared and irrigated, but much of it was later abandoned and now lies idle. Since the completion of the Arlington Canal in 1899 and the Gila Water Co. irrigation system in 1921, parts of the area have been developed and scattered ranch homes established. The Arlington district is the most thickly settled of the rural districts. The population consists mostly of white Americans, with a considerable proportion of Mexicans and negroes, and some Indians. A small part of the Gila Indian Reservation is included in the area surveyed. Gila Bend is the only incorporated town. Its present (1928) population is estimated at about 400. It is a railroad point on the Southern Pacific Railroad, and the junction point of the Tucson, Cornelia & Gila Bend Railroad, a branch line extending to the mining town of Ajo, Pima County. Gila Bend is also an important stopping place for automobile tourists. Arlington is a small settlement, and Theba, Piedra, and Smurr are railroad sidings. A cotton gin is located at Theba.

The local market is, of course, practically negligible. Cotton, cattle, and sheep are shipped to distant eastern or Pacific coast markets. Alfalfa seed also is shipped out.

United States Highway No. 80 (the Old Spanish Trail), which passes through Gila Bend, is the main highway between Phoenix and Los Angeles. It is a graded graveled road, in many places rather rough, but oiling is now under way and will soon be completed. Other roads are of dirt construction, are rather rough, and at times very muddy.

CLIMATE

The Gila Bend area, in common with all the lower parts of southwestern Arizona, is characterized by a hot, arid climate and a high proportion of sunshiny days. The daily range of temperature is great, the nights being comparatively cool on account of the rapid radiation consequent to the dryness of the atmosphere. Summer temperatures are often very high, a maximum temperature of 120° F. having been recorded at Gila Bend. The winters are mild, and freezing temperatures occur only a few times each year. The lowest temperature on record is 11°. The mean annual temperature is 71.5°, one of the highest mean temperatures in the State. The average frost-free season is 298 days, the average date of the latest killing frost being February 11 and that of the earliest, December 7. Killing frost has been recorded as late as March 28 and as early as November 13.

The annual precipitation is low and varies from year to year, ranging from 2.12 to 10.21 inches and averaging 6.08 inches. Most of the rainfall occurs during two periods, from July to September and from December to March. On account of its small quantity and irregular occurrence, the rainfall is largely negligible as an aid to

agriculture. Because of the low relative humidity of the atmosphere the rate of evaporation is high. Wind movement is generally not great.

Table 1, compiled from the records of the United States Weather Bureau station at Gila Bend, gives the more important climatic data for the area.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Gila Bend, Ariz.*

[Elevation, 737 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1900)	Total amount for the wettest year (1896)
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*
December	52.1	95	15	0.76	0	0.40
January	53.9	89	11	.84	0	1.20
February	56.5	95	24	.60	(1)	(1)
Winter	54.2	95	11	2.20	(1)	1.60
March	62.2	101	28	.66	1.00	1.10
April	68.0	108	28	.18	1.10	(1)
May	75.2	116	39	.08	.01	0
Spring	68.5	116	28	.92	2.11	1.10
June	86.3	120	48	.07	.01	0
July	92.0	120	58	.79	0	2.45
August	91.0	118	55	.84	0	2.58
Summer	89.8	120	48	1.70	.01	5.03
September	85.2	114	51	.39	0	1.06
October	72.9	106	35	.39	0	1.42
November	62.0	98	22	.48	0	(1)
Fall	73.4	114	22	1.26	0	2.48
Year	71.5	120	11	6.08	2.12	10.21

[1] Trace.

AGRICULTURE

The development of agriculture in the Gila Bend area is principally of recent origin and is not very extensive at the present time. Some expansion is now going on but it is hampered by the limited water supply during the summer. The first land was taken up and farmed in the early seventies. In 1894 the first large dam was built in Gila River and several thousand acres of land were irrigated by the water thus diverted. This dam was washed out by a flood, and the settlers, being without a water supply, were forced to abandon their ranches. A number of ineffectual attempts to harness the river were made. A large ranch, comprising about 5,000 acres, now diverts a small stream from the river near the pumping plant northwest of Gila Bend, with which it irrigates a few hundred acres. The pumping plant itself is idle. In the Arlington district the first crops were grown in the early nineties under the Buckeye Canal. In 1899 the Arlington Canal was finished. Under this canal are 4,800 acres of land, of which about 3,500 acres are now in cultivation.

On the Enterprise ranch, south of Gillespie Dam on the west side of Gila River, about 1,000 acres are irrigated from the Enterprise Ranch Canal by water diverted at Gillespie Dam.

Gillespie Dam was completed in June, 1921. This dam supplies water to the project of the Gila Water Co., comprising about 85,000 acres, of which, according to the company officials' estimate, 65,000 acres are tillable. In 1922 some development took place, in 1923 an acreage of 12,000 acres was farmed, and this amount was gradually increased until 15,000 acres were in crops in 1927. More land is being cleared and prepared for cultivation, and company officials estimate that between 18,000 and 19,000 acres will be in crops during the season of 1928.

The land on this project was first planted largely to cotton and farmed to that crop for a number of years in succession. The acreage of alfalfa is being increased, and this is now the main crop, 6,500 acres being in alfalfa in 1927. A system of rotation is planned with alfalfa as the main crop and cotton and small grains as secondary crops. The land is being farmed mostly in large units. The Gila Water Co. is farming several thousand acres, and the Abbott ranch includes about 10,000 acres.

In growing alfalfa the common practice is to irrigate the land freely when water is plentiful, in the autumn, winter, and spring, and to cut two crops of hay in the spring, later allowing the fields to become dry and the crop to go to seed. After the seed has been harvested in the fall the land is again irrigated, and cattle and sheep are pastured on the new growth. In this way an average yield of about 2½ tons of hay and from 75 to 80 pounds of seed to the acre are obtained. During the winter of 1927–28, 1,700 head of cattle and 10,000 sheep were pastured and fed on the alfalfa land.

Barley is often planted in the fall on alfalfa sod, or alfalfa is sown with barley as a nurse crop. This is generally pastured in the winter and early spring and later cut for hay. In 1927, the acreage in barley and alfalfa mixed was 1,500 acres, and barley alone, most of which was harvested for grain, was grown on 700 acres and produced an average yield of 10 sacks (120 pounds each) to the acre. Only 160 acres of wheat were grown on the project.

Cotton occupied an area of 2,200 acres in 1927. Short-staple cotton, principally Acala and Mebane, was grown. The best yields were 1 bale to the acre, and the average was about 0.7 bale.

Hegari (a grain sorghum) was grown on 1,100 acres in 1927, and yields ranged from 1 to 2 tons of grain (tops) to the acre.

In the Arlington district a total of 3,500 acres of land, or practically all that is considered tillable, is under cultivation, of which 1,500 acres were devoted to alfalfa. In addition to the hay crop, an average of 400 pounds of seed to the acre was produced in 1927. One hundred acres devoted to cotton produced about three-fourths bale to the acre. Grain and pasture land comprised 1,900 acres.

On the Enterprise ranch approximately 1,000 acres are under cultivation, principally of alfalfa, and a small acreage is devoted to Bermuda-grass pasture.

On the ranch of the Gila Land & Cattle Co., a few hundred acres were under cultivation in 1927, the greater part of the land being devoted to alfalfa and alfalfa and barley mixed. Small acreages were in barley alone, grain sorghum, and Bermuda-grass pasture.

A few small truck gardens supply produce to the local market. Dairying is engaged in on a small scale to supply the local demand, and turkeys, chickens, and other poultry are raised on many ranches.

In developing this country water has been applied to the land which could be most easily irrigated and cultivated. This practice has led to the development of the large smooth body of land surrounding Theba in the southwest part of the area. Here, the soils are of a texture favorable to easy cultivation, are free from alkali, and are of reasonably high water-holding capacity. They include Laveen sandy loam, Laveen fine sandy loam, and Mohave loam, which are recognized as being well adapted to alfalfa and cotton and also as producing satisfactory crops of hegari and the small grains.

In the Arlington district, along the river below Gillespie Dam, and lower, on the ranch belonging to the Gila Land & Cattle Co., the recent alluvial soils of the Gila and Pima series are generally recognized as well as adapted to alfalfa, cotton, small grains, and pasture grasses. The lighter-textured Gila soils, such as the fine sandy loam, are considered better for cotton and somewhat better for alfalfa than are the heavier Pima soils. Small grains, hegari, and Bermuda grass do better on the heavier soils such as Pima silty clay loam and Pima silty clay.

Large areas of land which are gravelly or stony and have an uneven surface remain idle. They would require much labor and expense for leveling and would be hard to cultivate, and they are not well adapted to most of the common crops of the region. Among these soils are Laveen gravelly sandy loam and Pinal gravelly sandy loam. Small areas of Gila sandy loam have been brought under cultivation and additional areas of this soil might easily be developed, but, owing to its coarse, porous character, the soil requires an excessive amount of irrigation water. Much of the alfalfa planted on it has suffered from drought. Other common crops do not seem to be well adapted to this soil, though cotton might do fairly well.

Crop rotation, including the growing of alfalfa, cotton, and small grains, is commonly practiced in this area. Very little fertilizer is applied to the soil.

Farm buildings are generally of cheap construction. The larger ranches have groups of small frame houses, or shacks, for employees and sheds for machinery. Barns are almost unknown.

Most of the common farm labor is performed by Mexicans and negroes, with a few white Americans as foremen.

The price of land ranges widely. Much of the land is of practically no value, but the better-irrigated lands are valued as high as $125 or more an acre. Raw lands of the Gila and Pima soils near Gila River, which are without water but for which there is the possibility of development of a water supply, are held at $20 or $25 an acre. Cultivated lands of the Gila and Pima soils in the Arlington district and of Laveen sandy loam, Laveen fine sandy loam, and Mohave loam in the vicinity of Theba range in value from $75 to $125 or more an acre.

The development of much of the land in this locality is dependent on obtaining an adequate supply of good irrigation water. Until this is accomplished it will be impractical to irrigate any but the best land and the most cheaply irrigated soils. On soils now lying idle as well as on those already in cultivation it may at some time

prove practical to develop not only the production of the common crops now grown but of subtropical fruits, such as dates, oranges, grapefruit, figs, and grapes, also melons, lettuce, tomatoes, sweet-potatoes, and other truck crops. Pecans give some promise. All of these crops are being successfully grown on similar soils in the Salt River Valley which lies northeast of the Gila Bend area.

All the soils of this area are low in organic matter and nitrogen but high in the mineral elements—potash, phosphorus, and lime. In the farming system an effort should be made to incorporate organic matter in the soil. This can best be accomplished by growing alfalfa in rotation with the other crops. Plowing under leguminous cover crops, such as cowpeas and tepary beans, is recommended by the Arizona Agricultural Experiment Station. Conserving manure and applying it to the land is another practice which is highly recommended. In the growing of some of the truck and fruit crops in southern Arizona the use of commercial fertilizers, especially those rich in nitrogen, has proved to be a profitable practice. Fertilizers containing phosphoric acid have also been tested, and the results of experiments show that they have beneficial effects on some crops.

SOILS

In the Gila Bend area 5 soil series, including 14 soil types and 2 subordinate phases, are mapped and in addition, 3 classes of miscellaneous materials.

A soil series represents a group of soils which differ from one another in texture of the surface soil but have certain properties or characteristics in common, such as color, physical and chemical character of surface soil and subsoil, and drainage. The series separations in this area were made largely on the basis of the degree of compaction and lime concentration in the subsoils and to some extent on the color of the surface soil. A soil type represents a textural division within the soil series, or a division based on the size of the soil particles composing the surface soil. The textures mapped here include gravelly sandy loam, sandy loam, fine sand, very fine sand, fine sandy loam, very fine sandy loam, loam, silt loam, silty clay loam, and silty clay. Soils of heavy texture are those which contain high proportions of the finer soil particles, such as clay and silt, and light-textured soils contain higher percentages of the coarser particles, as stone, gravel, and sand of various grades. A phase is a subdivision within a soil type, which has been recognized because of minor differences in topography, texture, or other soil characteristics.

The soils of the Pinal series are characterized by a shallow surface mantle of light reddish-brown, pinkish-brown, or light-gray soil, overlying a lime-cemented hardpan or caliche layer which is in most places very hard, having much the appearance of concrete, and is not perceptibly softened by the application of water. Both surface soil and subsoil are typically gravelly, and a surface coating of dark-colored gravel or "desert pavement" is found on much of the soil as mapped in this area.

The Laveen soils have light grayish-brown or pinkish-brown friable calcareous surface soils over light-gray or pinkish-gray very compact limy subsoils. Many hard lime-carbonate nodules are

present throughout the surface soil and subsoil and occur in considerable quantities over most of the surface.

The Mohave soils are characterized by light reddish-brown or pale-red surface layers over pale-red more compact heavier subsurface layers, and mottled red and gray very highly calcareous heavy compact subsoils.

The Gila soils consist of comparatively recent alluvial deposits, and they have friable or only slightly compacted subsoils. Surface soils and subsoils are distinctly calcareous, but without marked concentration of lime in any one horizon. The color of the surface soil ranges from light grayish brown or pinkish brown to light reddish brown or chocolate color.

The Pima soils are very similar to the Gila soils, the principal difference being in the color of the surface soils, which ranges from dark chocolate brown or dull reddish brown to dark brown. The surface soils have been deposited largely by turbid irrigation water.

In the following pages the various soils are described in detail and their agricultural possibilities are discussed; the accompanying soil map shows their location; and Table 2 gives their acreage and proportionate extent in the area.

TABLE 2.—*Acreage and proportionate extent of soils mapped in the Gila Bend area, Arizona*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Laveen sandy loam	20,544	16.0	Gila sandy loam	12,544	8.7
Light-textured phase	2,368		Gila very fine sandy loam	5,248	3.7
Laveen fine sandy loam	9,728	6.8	Gila very fine sand	1,344	.9
Laveen gravelly sandy loam	20,416	14.2	Gila silt loam	3,328	2.3
Mohave loam	1,024	.7	Gila loam	3,520	2.5
Pinal gravelly sandy loam	14,848	10.4	Gila fine sand	4,224	2.9
Pima silty clay loam	4,544	3.2	River wash	14,016	9.8
Pima silty clay	576	.4	Rough stony land	7,744	5.4
Gila fine sandy loam	13,632	11.7	Scab land	512	.4
Hummocky phase	3,200		Total	143,360	

LAVEEN SANDY LOAM

Laveen sandy loam is the soil of greatest agricultural importance, both present and potential, mapped in the Gila Bend area. It occurs most extensively in the western part, from Smurr west and northwest to within 2 or 3 miles of the Painted Rock Mountains. Two small bodies are on the west side of Gila River about 5 miles south of Gillespie Dam, and two others, one about 4 and one 8 miles above the dam. This is an upland soil with a smooth or gently undulating relief and is well drained.

The surface layer of Laveen sandy loam is light grayish-brown or pinkish-brown friable calcareous sandy loam to an average depth of about 6 inches. A large number of hard gray lime-carbonate nodules occur in most places on the surface, and a small amount of gravel is scattered over the surface in some places, but not in such quantities as to materially affect cultivation. Below the surface layer and extending to a depth ranging from 12 to 20 inches is a somewhat more compact layer having a lighter or grayer color and containing many nodules. The subsoil is mottled light-gray or

pinkish-gray very compact and nodular gritty loam or clay loam which is tough and forms rather hard clods when dry but softens when moistened. Beneath this at an average depth of about 40 inches is a somewhat redder and slightly less compact layer having a somewhat lower lime content. In a few places the friable surface layer is very thin, the compact subsoil coming within a few inches of the surface. Such spots have a somewhat grayer color than typical.

This soil, together with its light-textured phase, comprises 35.8 square miles of the Gila Bend area. About 10 square miles of this is now under cultivation. Most of the remainder is well suited to irrigation farming and probably will be gradually brought under cultivation if an adequate supply of irrigation water can be provided. No fertilizer and only a small quantity of stable manure is applied to the soil.

The common crops grown on this soil are alfalfa, cotton, barley, and hegari. In 1927 probably about 55 per cent of the cultivated area was in alfalfa, 18 per cent in cotton, 12 per cent in an alfalfa-barley mixture, 10 per cent in hegari, and 5 per cent in barley alone. Alfalfa is cut twice in the spring for hay, averaging about 2½ tons to the acre. After the second cutting it is allowed to go without irrigation and a crop of seed, which averages between 75 and 80 pounds to the acre, is harvested in the summer. In the fall the alfalfa land is irrigated and used as pasture for range cattle and sheep.

This land may at some time be used for growing citrus fruits, dates, and other subtropical fruits if a sufficient year-round supply of water can be obtained.

The natural vegetal covering consists largely of creosote bush (*Covillea glutinosa*), with a small quantity of desert sage and rabbit bush or bur sage in places, as well as a very few small mesquite trees. Clearing the land is cheaply and easily accomplished by means of a heavy drag. Little leveling is necessary in most places, though in some of the more rolling areas considerable work may be necessary to properly level the land for irrigation.

Laveen sandy loam, light-textured phase.—Laveen sandy loam, light-textured phase, is very similar to typical Laveen sandy loam, but it has a coarser, looser surface soil which probably represents sandy material blown from the desert washes. The texture ranges from light sandy loam or loamy sand to sand. In places the surface soil is fairly firm. Small dunelike hummocks or ridges occur in places.

Areas of this light-textured soil border areas of typical Laveen sandy loam northwest of Theba.

None of the land is under cultivation at the present time. On account of its somewhat more rolling and hummocky relief, it will require more leveling for irrigation than the typical soil. Also, its looser surface soil will necessitate the use of a larger head of irrigation water, and the moisture-holding capacity will be somewhat less. Some trouble will doubtless be experienced on account of blowing of the surface soil. The land will probably not be quite so well adapted to the growing of small grains as Laveen sandy loam. The deposition of silt by irrigation water will help to correct the defects of this soil by gradually making the texture heavier.

LAVEEN FINE SANDY LOAM

Laveen fine sandy loam ranks second among the soils of the area in agricultural importance. It occupies a total area of 15.2 square miles, of which probably 60 or 70 per cent was under cultivation in 1927. It occurs in a large rather uniform body in the southwest part of the area around Theba.

This soil is very similar to Laveen sandy loam, except that it has a finer-textured surface soil which ranges from fine sandy loam to medium sandy loam and in a few small areas approaches a loam.

The soil occupies smooth very gently sloping upland fans and is well drained and excellently adapted to irrigation. No harmful alkali concentrations are found in this soil, though traces of alkali occur in the subsoil. The natural vegetation consists largely of creosote bush, with a small amount of rabbit bush and a few small mesquite trees. The land is easily and cheaply cleared and requires very little leveling for irrigation.

LAVEEN GRAVELLY SANDY LOAM

Laveen gravelly sandy loam is extensive but is of little agricultural importance. A large body of this soil lies at the foot of the Painted Rock Mountains, and smaller bodies occur from there eastward to Gila Bend and thence northeast halfway to Gillespie Dam. One small body is about 2 miles south of Gillespie Dam, and above the dam a number of rather small bodies occur along the margins of the area on both sides of the river. The soil occupies upland fans having a somewhat rolling or ridgy surface. Drainage is good or excessive.

The surface soil of Laveen gravelly sandy loam is light-gray or pinkish-brown friable or somewhat loose calcareous gravelly or stony sandy loam. A heavy surface concentration of gravel or " desert pavement " occurs over considerable of the soil. The subsoil, which consists of light-gray softly cemented gravelly sandy loam or gravelly sand, begins at a depth of a few inches and in most places extends to 40 or more inches, where it is underlain by a loose porous mass of gravel.

The soil comprises a total area of 31.9 square miles, almost none of which is under cultivation. It seemingly has little agricultural value on account of the coarse gravelly or stony character of the surface soil and subsoil and the unfavorable relief. In most places considerable leveling would be necessary to enable the land to be properly irrigated, and this would expose the limy, gravelly subsoil, which is unfavorable to the growth of crops. The smoother areas may possibly prove well adapted to the growing of oranges, grapefruit, or other subtropical fruits.

The natural vegetation consists of creosote bush and rabbit bush, with occasional giant and cholla cacti, paloverde, and ironwood.

MOHAVE LOAM

Mohave loam as mapped in this area is light reddish-brown somewhat calcareous friable loam to an average depth of about 8 inches. The upper subsoil layer, which extends to a depth of about 30 inches, is reddish-brown or pale-red somewhat compact heavy loam or clay loam, slightly mottled with light-gray streaks of lime carbonate.

The deeper subsoil layer is light reddish-brown or grayish-brown compact heavy loam or clay loam, which is very limy, much mottled with light gray, and contains a considerable number of hard lime nodules.

This soil occurs mainly in one long, narrow body southwest of Theba, and smaller bodies are northeast of that place and west of Piedra. It occupies flats which are slightly lower than the surrounding upland fans, and it receives much of the drainage from the fans. The soil is not poorly drained, however, and contains no harmful accumulations of alkali, though traces are found in the subsoil. This soil is inextensive in the Gila Bend area. Most of the land is under cultivation, producing alfalfa and cotton. Yields are much the same as on Laveen sandy loam and Laveen fine sandy loam.

PINAL GRAVELLY SANDY LOAM

Pinal gravelly sandy loam occurs on the older, rougher alluvial fans along the foot of the Painted Rock Mountains and along the edge of the Gila River bottom lands northwest of Gila Bend. Smaller areas occur several miles northeast of that town and both below and above Gillespie Dam in narrow strips lying along the boundaries of the area. The total extent of this soil is 23.2 square miles.

Typical areas of Pinal gravelly sandy loam have a "desert pavement" or heavy surface concentration of gravel and stones which are covered with a dark-brown or black polish (desert varnish). In many places the surface soil is only a few inches thick, though in places it is a foot or more deep. The color range is from light gray or pinkish gray to pale reddish brown or pinkish brown. The surface soil grades with depth into grayer and more limy material and is underlain by solidly cemented lime-carbonate hardpan or caliche. Smaller areas of this soil, which are comparatively free from the heavy surface pavement, are light gray in color and seemingly represent spots where the original surface soil has been removed by erosion. In many such areas the hardpan outcrops on the surface.

This soil apparently has no agricultural value, and no effort has been made to cultivate it. The shallow, coarse soil and the rolling, uneven, and in places badly dissected areas offer little promise of adaptability to the growing of agricultural crops.

PIMA SILTY CLAY LOAM

Pima silty clay loam, though comparatively inextensive, is of some agricultural importance, as it is largely under cultivation. It occurs in the Gila River bottom lands south of Arlington, in strips paralleling the river on each side several miles below Gillespie Dam, and on the Gila Land & Cattle Co.'s ranch north of Theba. This soil is a comparatively recent river deposit, having a surface soil composed largely of silt and clay, most of which has been deposited by turbid irrigation water.

This soil has a surface soil, from 3 to 12 or more inches thick, of dull-brown or, in some places, dark-brown silty clay loam, overlying a lighter or more reddish-brown friable or slightly compact subsoil which consists of irregularly stratified material ranging in texture from clay loam to fine sand. In many places the subsoil is predom-

inantly rather uniform fine sandy loam. Both surface soil and subsoil are distinctly limy, a slight concentration appearing in the subsoil in most places.

The total extent of this soil is 7.1 square miles, of which about three-fourths is under cultivation. The cultivated land is devoted largely to alfalfa, barley, and Bermuda-grass pasture. Small quantities of cotton, wheat, and hegari are also grown. Alfalfa yields from 2 to 8 tons of hay, and where grown for seed it yields an estimated average of 400 pounds to the acre. The yield of cotton of the short-staple variety is about three-fourths bale. Barley and mixed barley and alfalfa are used largely for hay and pasture. A large part of the barley is harvested for grain after being pastured early in the season. Similar soils in the Salt River Valley are producing good crops of high-quality lettuce.

Drainage of this soil ranges from fair to poor, and in places the water table is within 6 feet of the surface.

Alkali salts are usually present in considerable quantities. In areas which have been properly leveled and irrigated by flooding, harmful quantities are seldom found, but in many places where the land has lain idle, a strong surface concentration has accumulated. Such areas will require special treatment for successful reclamation.

PIMA SILTY CLAY

Pima silty clay occurs southwest of Arlington in the same general location as Pima silty clay loam. It is not extensive, less than 1 square mile being mapped.

This soil is very similar to Pima silty clay loam but is somewhat heavier in texture and in many places has a deeper surface layer. The surface soil is dull-brown or dark-brown rather compact and cloddy silty clay. The subsoil is lighter reddish brown and consists of stratified heavy and medium textured materials. The heavier layers are somewhat compact and cloddy and in many places contain faint mottling or veining of gray lime carbonate.

Land of this kind is largely under cultivation, mainly to alfalfa and pasture grasses. It seems well adapted to small grains. Drainage ranges from fair to poor, and the alkali content ranges from slight to strong.

GILA FINE SANDY LOAM

Gila fine sandy loam is a rather widely distributed soil in this area. It occurs in long narrow strips paralleling the river in the bottom lands and on the gently sloping alluvial fans bordering the river bottoms. It has been deposited in comparatively recent times by the river and the lateral washes which drain into the river.

The surface soil is light-brown or light pinkish-brown mellow fine sandy loam or loamy fine sand to a depth of 6 or more inches. The subsoil in most places is very slightly more compact and slightly higher in lime content than the surface soil. In most places the deeper part of the subsoil is rather loose stratified material ranging from fine sandy loam to gravelly sand.

The total extent of this soil, together with its hummocky phase, is 26.3 square miles, but not more than 2 or 3 square miles is under cultivation. Cotton, alfalfa, and Bermuda-grass pasture are the principal crops grown. Cotton is reported to yield from one-half

to one bale to the acre. There is possibility of considerable future development of this soil, as it seems fairly well adapted to cotton, alfalfa, and the small grains; and probably pecans, grapes, dates, melons, and other truck and fruit crops may be grown to advantage.

Drainage varies considerably in this soil; lower-lying areas on account of their position have comparatively poor underdrainage, whereas in some of the higher-lying areas having sandy or gravelly subsoils the underdrainage is excessive. The soil also varies in alkali content, being practically alkali free in the higher places and strongly affected in some of the lower-lying spots. The relief ranges from fairly smooth to somewhat ridgy and hummocky. The larger and more conspicuous areas having an uneven surface are mapped as a hummocky phase.

Creosote bush forms the vegetation on parts of this soil, but desert sage is the more characteristic vegetation, and mesquite, cottonwood, and seepweed grow on the lower areas.

Gila fine sandy loam, hummocky phase.—The hummocky phase of Gila fine sandy loam is similar to typical Gila fine sandy loam with the exception of the hummocky, uneven character of the surface. The texture is somewhat lighter on the hummocks, being loamy fine sand, and is heavier in the hollows than that of the typical soil. Erosion and wind drifting of the sandy surface soil are probably largely responsible for the hummocky surface. The surface soil of most of the hummocks is practically alkali free, but the surface soil of the hollows and the subsoil both on the hummocks and in the hollows are generally rather strongly impregnated with alkali salts. In the bodies of this phase lying near the extreme northeast part of the area both surface soil and subsoil are practically alkali free.

This soil occurs in a number of bodies several miles northwest of Gila Bend and in other long narrow strips paralleling the river both above and below Gillespie Dam.

GILA SANDY LOAM

Gila sandy loam is a rather widely distributed soil in the Gila Bend area, forming gently sloping alluvial fans or alluvial bottom lands along desert washes which drain into Gila River. Its greatest development is from Gila Bend northeastward about 10 miles. Many smaller bodies are scattered throughout the area.

This soil is characterized by a light grayish-brown or light pinkish-brown sandy loam, loamy sand, or sand surface soil and a friable or very slightly compacted subsoil which is similar to the surface soil but slightly more limy. The deeper part of the subsoil, or substratum, is generally of loose stratified sandy and gravelly material. The soil contains a considerable amount of angular granitic grit and fine gravel. In some narrow strips close to the washes considerable coarser gravel and a small quantity of stone are present. The larger and more conspicuous bodies of this coarser material have been indicated on the map by gravel symbols.

The total extent of Gila sandy loam is 19.6 square miles. Of this probably not more than 400 acres is cultivated, being devoted to alfalfa and alfalfa and barley mixed. On account of the loose droughty character of the soil and the scarcity of water, crop yields

have been light. If provided with a large amount of irrigation water, the soil would no doubt produce good crops of alfalfa and cotton, and prove well suited to the production of grapes, dates, citrus fruits, and melons.

The natural vegetation consists largely of creosote bush, with paloverde and ironwood trees along the washes.

GILA VERY FINE SANDY LOAM

Gila very fine sandy loam consists of recent alluvial deposits carried by Gila River, and this soil lies in the bottom lands, not far from the stream, throughout the length of the area.

The surface soil is friable light-brown or light grayish-brown fine or very fine sandy loam having a slightly pink tinge. The subsoil consists of stratified light grayish-brown or light pinkish-brown materials ranging from silt loam to fine sand in texture. In most places it includes a layer which shows slight compaction and a slight accumulation of lime.

Areas of this soil range from fairly level to slightly ridgy. Drainage is fair or poor, and the alkali content ranges from very slight to strong.

The natural vegetation consists largely of desert sage and seepweed, with a scattered growth of mesquite.

Only a few hundred acres of this soil are under cultivation, producing satisfactory yields of all the common crops of the district. Where not too strongly alkali affected, the soil is well adapted to all of these crops and if supplied with sufficient water would also be suitable for the growing of pecans, dates, grapes, melons, and other fruit and truck crops.

GILA VERY FINE SAND

Gila very fine sand consists of comparatively recent deposits from Gila River. It occurs in narrow strips near and parallel to the river channel. It is most extensive on the west side of the river below Gillespie Dam, but small areas occur above the dam and northwest of Gila Bend.

This soil is very similar to Gila very fine sandy loam. The surface soil is mellow light-brown, light grayish-brown, or pinkish-brown very fine sand or loamy very fine sand. The subsoil is of similar or somewhat lighter-textured friable material which is considerably stratified.

The land is smooth, somewhat hummocky, or ridgy, and drainage is fair or poor. Alkali is present in quantities ranging from harmless amounts to strong concentrations.

None of this soil is under cultivation. It supports a natural vegetal covering of arrow weed, desert sage, seepweed, and mesquite. Its agricultural value and crop adaptations are similar to those of Gila very fine sandy loam.

GILA SILT LOAM

The surface soil of Gila silt loam consists of slightly compact or granular and friable silt loam which is light brown or light grayish brown with a slightly red tinge. The subsoil is light reddish-brown friable fine sandy loam or stratified material ranging from silt loam to fine sand. In places a zone of slight compaction and lime veining

occurs in the subsoil at various depths. Much of the soil supports a thick growth of mesquite, and in such places a thin layer of dead leaves and twigs covers the surface. In other places the typical vegetation is desert sage and seepweed, with creosote bush in a few of the better-drained areas.

This soil occurs in low-lying strips, and much of it has been subject to occasional overflow. Drainage is not very well developed in many places, though parts of the soil are fairly well drained. The alkali content ranges from very low to high.

Only a few acres of the soil are under cultivation at the present time, though some of the land was cleared at one time but was later abandoned and allowed to grow up in mesquite. With a sufficient supply of irrigation water, this soil should prove well suited to alfalfa, small grains, hegari, and cotton. Melons, lettuce, and other truck crops are grown extensively on similar soils in the Salt River Valley.

GILA LOAM

Gila loam occurs in rather small bodies scattered along the Gila River bottoms from the upper end of the area to the lower end. The surface soil is typically loam of silty texture and light pinkish-brown color. In many places a very thin surface crust is present, under which is a loose granular mulch from 1 to 3 inches in thickness. Below this the soil material is somewhat puddled and compacted and contains fine netting or veining of lime and crystals of alkali salts. The upper part of the subsoil in many places is rather compact and heavy and slightly mottled with lime, and below a depth of 3 feet it is mellow and of medium or light texture.

The greater part of this soil is rather poorly drained and badly affected with alkali, and the friable consistence of both surface soil and subsoil has been somewhat modified by alkali puddling. In the small areas, where drainage and alkali conditions are better, the soil is more friable and is more typical of soils of the Gila series.

Very little of the land is under cultivation. On account of poor drainage and the presence of strong alkali concentrations, special measures are necessary for its reclamation, such as improved drainage and an ample supply of irrigation water for flooding and leaching the land. If reclaimed, the land would probably have much the same value and the same crop adaptations as Gila silt loam.

GILA FINE SAND

The surface soil of Gila fine sand is light grayish-brown or light-brown loose fine sand. The subsoil is loose sandy more or less stratified material.

This soil occurs along Gila River, most of the areas bordering river wash. It is loose and leachy and has little agricultural value. Much of the soil is free of alkali, though some of the lower, wetter spots contain considerable alkali. Much of the land is subject to occasional overflow. Some areas of this soil if provided with sufficient water might be utilized for the growing of pecans, dates, grapes, and other subtropical fruits.

Arrow weed forms the vegetation on much of the soil, and jimmy weed is common.

RIVER WASH

River wash includes the loose sandy and gravelly areas along Gila River and a few of the larger lateral washes, which are exposed in periods of low water but are largely covered at flood stages. On account of its coarse, leachy character and owing to the fact that it is subject to overflow, river wash, in general, lacks agricultural value.

This class of land covers 21.9 square miles within the Gila Bend area. In a body comprising about 1½ square miles just above Gillespie Dam the soil material is silty or clayey in texture and is, therefore, not like other areas of river wash, but has been included with mapped areas of this material. Here, the backing up of water by the dam has developed a wet marshy area.

ROUGH STONY LAND

The Painted Rock Mountains along the west edge of the area consist largely of bare rock, partly covered by loose rock debris. These mountains and parts of the rougher stony slopes at their bases are mapped as rough stony land. A few small detached buttes standing out along the base of the range are included in this classification. Small areas of rough stony land are also mapped above Gillespie Dam and just north of Arlington.

The vegetal covering consists of scattered creosote bush, paloverde trees, and giant cacti. This land has only a very limited value for grazing.

SCAB LAND

Scab land is somewhat similar to rough stony land, but it is not so rough and has a deeper soil covering. It occurs on old lava flows and is characterized by many protruding knobs of dark volcanic rock. The soil covering is much like Pinal gravelly sandy loam and would have been so classified had it not been for the occurrence of numerous rock outcrops and the rolling knobby relief.

Scab land is of no crop value and of but little grazing value.

IRRIGATION, DRAINAGE, AND ALKALI

Further development of land in the Gila Bend area is retarded by a shortage of water, which becomes acute during the summer. The natural flow and flood waters of Gila River are utilized for the Gila Water Co. project, but no water storage is provided. The river provides enough water in the fall, winter, and spring, but when the river is low in summer and the need of water is great the supply falls far short of the requirements. This situation has been aggravated by the buildng of storage dams higher up on Gila Rver and on its tributaries, Salt and Agua Fria Rivers. The stored water is used on irrigation projects above this one, and the flow of the river is greatly reduced. In the course of years the return flow of drainage and seepage waters from these projects may again increase the summer flow of Gila River to some extent.

Another possible source of irrigation water is from wells. In the Gila River bottom lands the level of the ground water is comparatively close to the surface and the pumping lift is not great.

Much of the available water is comparatively high in alkali salts, though the content of black alkali (sodium carbonate) is low in most places. Tests showed that the salt content in the river waters ranged from 75 to 360 parts per 100,000 [1] at different stages of water during the period when the survey was made. The salt content is always greater when the river is low, and decreases as the flow increases. In samples of water taken from a number of wells the alkali salts constituted from 90 to 260 parts per 100,000. Such water when applied to alkali-free soil must raise the salt content of the soil to some extent. On the other hand, land in which the salt content is high may be benefited by such application.

The duty of water in this region varies greatly on the different soils and with the kind of crop grown. The results of irrigation experiments and observations carried on in the Salt River Valley by the Bureau of Public Roads, United States Department of Agriculture, cooperating with the Arizona Agricultural Experiment Station [2] are as follows: (1) The average net duty of water (water actually applied to the land) is about 3 acre-feet; (2) alfalfa yields increase with the application of water up to 7 acre-feet a year, though 4 acre-feet is considered a safe quantity to use to protect the land from water-logging; (3) the yield of cotton is increased by an increase in the water up to a total of 2¼ or 2½ acre-feet a year; (4) the quantity of water which should be used to irrigate small grain ranges from 1.4 to 1.8 acre-feet a season; (5) grain sorghum should receive from 0.75 to 1.3 acre-feet of water during a season; (6) water losses from irrigated fields can be greatly reduced by more careful preparation of the land and closer attention to the application of water; (7) border strips or furrows on the average soils should not be longer than one-fourth mile and on some of the looser soils should be much shorter; and (8) the head of water used, the length and width of land watered at one time, and the slope of the land in the direction of irrigation should be such as to result in even, rapid application of water to the soil.

In the Gila Bend area the soils vary more in their texture and water-holding capacity than do soils in the Salt River Valley. In the Gila Bend area most of the soils are of somewhat lighter or sandier texture, and a number of them are droughty and can be watered evenly only with difficulty. The coarse porous material in the surface soil and subsoil of Gila sandy loam does not retain moisture well, the land requires frequent irrigation, and it is difficult to irrigate without excessive loss of water through downward percolation. The same is true of Gila fine sand and parts of Gila fine sandy loam. On such loose soils the rule should be to use a large head of water and short runs. The light-textured phase of Laveen sandy loam may also cause some difficulty in proper distribution of the water, though the subsoil has good water-holding capacity. Laveen sandy loam, Laveen fine sandy loam, Mohave loam, the Pima soils, and the medium-textured Gila soils including the loam, silt loam, very fine sandy loam, very fine sand, and parts of the fine sandy loam, take and hold moisture well.

[1] The tests of river and well waters were made by F. O. Youngs, through the use of an electrolytic bridge, during the progress of the soil survey.

[2] MARR, J. C. THE USE AND DUTY OF WATER IN THE SALT RIVER VALLEY. Ariz. Agr. Expt. Sta. Bul. 120, pp. 55–97, illus. 1927. (Preface by G. E. P. Smith.)

Drainage is not a problem on most of the lands of this area at the present time, though in the reclamation of alkali soils drainage ditches may prove beneficial in keeping down the level of the ground water. If large areas of the higher lands are irrigated in the future this may cause seepage and a high water table in the lower river-bottom lands, and artificial drainage of these lower lands may have to be resorted to.

The accumulation of alkali salts presents a problem in this area, especially in view of the fact that the available irrigation waters contain considerable quantities of these salts, as has been previously stated. The majority of the soils of the area are practically alkali free, but the lower-lying lands, which include most of the soils of the Gila series and those of the Pima series, are slightly or strongly affected with alkali, owing probably, mainly to natural accumulation of the salts in the low, poorly drained areas, but partly to seepage or irrigation from ditches leading from Gila River. Many of the old ditches are now abandoned, and much of the land bordering them and lying below them is more strongly affected than the land above.

Three grades of land based on the degree of alkali accumulation are shown on the soil map as follows: (1) The alkali-free soils shown by the letter F, in which the content of alkali salts is so low as to be practically negligible; (2) the slightly or moderately affected soils designated by the letter S, in which the alkali concentration is somewhat greater, generally having some effect on vegetation and crop growth; and (3) the strongly affected soils shown by the letter A, in which the salts largely preclude successful crop growth and require special measures for reclamation before successful growth can be obtained. It should be understood by the reader that the mapping of alkali-affected areas is necessarily of a very general nature. The alkali concentration in the soils in this region is very "spotted," and two tests made 100 feet apart may give very different results. Therefore, the results of field tests for alkali, given on the map, serve merely to give a general idea of the range of salt concentrations.

The appearance of the soil and the vegetation were used as guides in the mapping of alkali in the field, and the electrolytic bridge was used in making tests to check the field observations. In general the soils of the alkali-free groups have a concentration of less than 0.2 per cent of alkali salts to a depth of 6 feet. A few tests showed more than this amount, which in most places was concentrated largely in the subsoil. The alkali salts in soils of the second group, those slightly or moderately affected, range from 0.2 to 0.7 per cent, or rarely higher, to a depth of 6 feet. In a few places surface concentrations were slightly higher than this but the content of alkali in the subsoil was comparatively low. In other places the concentration in the surface soil was low, and below this and continuing to a depth of 6 feet the content was as much as 0.9 per cent or even more. Some of these tests doubtless represent extreme variations from the general average of the immediate locality in which the test was made. Most of the soils of the strongly affected group contain more than 0.7 per cent alkali salts to a depth of 6 feet. In some places the con-

centration in the surface soils is very low, as low as 0.05 per cent, but in other places it may be more than 3 per cent.

An interesting relationship exists between the character of the natural vegetation and the amount of alkali in the soil. Creosote bush, or greasewood [8] (*Covillea glutinosa*), is the characteristic vegetation on lands where the salt content is very low. This is associated with ironwood (*Olneya tesota*), paloverde (*Cercidium floridum*), rabbit bush or bur sage (*Franseria dumosa*), and several species of cacti including the giant cactus (*Carnegiea gigantea*) and cholla (*Opuntia* sp.). In places where slight or moderate alkali accumulations are found desert sage, or saltbush (*Atriplex polycarpa*), forms the greater part of the vegetative covering, mesquite (*Prosopis velutina*) is of frequent occurrence, and scattered squawbush (*Lycium parviflorum*) and broad-leaved saltbush are also found. Inkweed (*Dondia intermedia*) and seepweed (*D. torreyana*) appear as the concentration of alkali increases, and these, together with scattered desert sage, broad-leaved saltbush, and mesquite, are found on the strongly affected areas, though in some places where the concentration is highest there is no vegetation of any kind.

Reclamation of some of the strongly alkali-affected areas may prove feasible under certain conditions. Such reclamation has been accomplished in the Salt River Valley. The procedure followed is frequent and liberal applications of irrigation water by flooding. The water as it percolates downward through the soil dissolves and removes a part of the excess alkali salts. The effectiveness of this method depends on the texture and structure of the soil and subsoil, the underdrainage, and the quantity and character of the salts carried in the irrigation water. Artificial drainage may be essential in some places to lower the level of the ground water. Heavy soils or soils having tough heavy subsoils are, of course, harder to leach than are the lighter, more open soils.

SOILS AND THEIR INTERPRETATION

The Gila Bend area lies in the geographic climatic region known as the arid southwest. This region has high mean and very high maximum temperatures, a large amount of intense sunlight, a small annual rainfall, and a dry atmosphere.

The vegetative covering is sparse over the greater part of the area and has apparently had very little influence on soil development, though it shows some interesting relationship to soil moisture and alkali-salt content of the soils.

The soils of this region in general show marked common characteristics, owing to their formation under the climatic conditions enumerated above. They have light-brown or light grayish-brown surface soils with a distinct pink or red tinge and are very low in organic matter. The surface soil is almost invariably distinctly calcareous. This is one distinction between the soils of this area and some of those mapped in the Salt River Valley and Paradise-Verde areas. It is possibly due to a somewhat lower rainfall in this area. In the more mature soils the subsoils contain a very high con-

[8] Greasewood is the popular local name of the creosote bush. It should not be confused with the true greasewood (*Sarcobatus vermiculatus*) which is an alkali indicator.

centration of lime and are very compact or cemented. The soils of this area average sandier in texture than those of the Salt River Valley area.

Drainage is normally well developed except in some small areas of low-lying land along Gila River. Such areas consist only of recent alluvial soils of the Gila and Pima series, and the poor drainage has not had a marked influence on soil development.

On account of the low rainfall, comparatively little leaching has taken place in the soils of this region. There has been a heavy concentration of lime and other soluble alkali and alkaline-earth salts in the subsoil, but this concentration occurs at slight depths, and these salts have not been completely removed from the surface soil. The subsoils are generally heavier in texture than the surface soils, which probably means that there has been some infiltration of clay and colloids. However, it may be due partly to the concentration of coarse materials on the surface as the finer ones have been removed by wind. Also, the surface soils in many places represent lighter materials deposited by wind and by sheet wash over a heavier alluvial deposit.

The soil conditions just described are typified in soils of the Laveen series which are the most extensive soils of the area. These soils occupy upland fans where drainage is good. The conditions on areas which are slightly lower and flatter are best seen in Mohave loam. On such areas a greater amount of leaching has taken place, the subsoils are heavier and redder, and the lime is leached to a greater depth.

The red color of the soils of the Gila Bend area is probably due largely to the high state of oxidation consequent to exposure to the intense heat and sunlight. It is generally more marked in the older soils. The content of organic matter is so low that it has little effect on the soil color, except possibly in the Pima soils which are of recent alluvial origin.

The normally developed soil of the region is typified in the Laveen soils, in which the surface soil to a depth of about 6 inches is friable or very slightly compacted, in places having a thin soft easily crumbled crust with a vesicular structure. The color is light grayish brown or pinkish brown. Small hard lime-carbonate nodules are scattered over the surface. The upper subsoil layer to an average depth of about 18 inches is of slightly compact calcareous material which is somewhat grayer than the surface soil and is full of hard lime nodules. The lower subsoil layer is somewhat heavier in texture, is very compact or softly cemented, has a nodular cloddy structure, and is light pinkish gray in color. This limy layer resembles a cemented hardpan when thoroughly dry, but softens when moistened. Below a depth of about 40 inches the concentration of lime is somewhat less and the color is redder.

The Mohave soils show a slight variation from the typical Laveen profile. There has been a greater amount of leaching in the Mohave soils; the lime has been leached to a greater depth; and the subsurface soil is redder, heavier, and more compact than in the Laveen soils.

The Pinal soils exhibit an extreme development of lime accumulation in the subsoil, the lime forming a solidly cemented and very

hard stratum, resembling a conglomerate, which is commonly called hardpan, or caliche. The surface soil in many places is somewhat redder than in the Laveen soils, but in most places it lacks the compact red subsurface layer which characterizes the Mohave soils. The reason for the more extreme concentration of lime and cementation in soils of the Pinal series is problematic and perhaps open to debate. The theory has been advanced that it is due to deposition from percolating waters which drain from higher ground. This may be true in some places, but in others it hardly seems to give the proper explanation. Another theory is that the soil material has lain in place longer in the soils of this series, thus allowing a greater length of time for the accumulation of lime, by decomposition of the soil minerals and by leaching from the surface soil, and a consequent greater degree of concentration. The present surface soil may represent only a fraction of the depth of the material which once covered the lime hardpan, the remainder having been removed by erosion. This theory is strengthened by the occurrence of numerous outcrops of hardpan and the desert pavement or heavy surface accumulation of gravel. The occurrence of the Pinal soils on some high isolated knobs also argues for the latter theory as against the former.

In addition to the mature soils mentioned are soils of two series, the Gila and the Pima, which represent comparatively recent alluvial deposits. These soils, with a few minor exceptions, have existed under conditions of good drainage since deposition. They show some slight degree of modification due to weathering but in no place closely approach the more mature soils of the other three series.

The soils of the Gila series are generally light grayish brown or yellowish brown, with a slight pink or red tinge in many places. The subsoils are stratified and generally friable, though a zone of slight compaction containing an incipient accumulation and veining of lime and other salts occurs in most places. The depth of the lime accumulation is variable, depending on the texture of the various layers and the amount of recent deposition. In general, the heavier-textured layers show the greatest amount of lime and salt mottling. One soil of the series, the fine sand, is very loose, showing no trace of a compact or limy zone. The color of this soil is also somewhat duller, with less of the pink tinge, than in other soils of the series. This material might be considered as belonging to a separate series, but has not been so recognized in the other southern Arizona areas recently mapped. Gila sandy loam and some of the fine sandy loam are of slightly different origin than the other Gila soils. They occupy the alluvial bottoms or fans of the desert washes tributary to Gila River. The material is almost entirely granitic and contains much coarse angular granitic grit, whereas that of the other soils of the series is river laid, of greatly mixed lithologic character, and the soil particles are finer and more rounded. It is possible that the sandy loam and parts of the fine sandy loam should be considered as belonging to a different series.

In most of the Gila loam and in parts of the fine sandy loam, silt loam, and very fine sandy loam, the soils have been modified by the concentration of alkali salts consequent to comparatively poor drainage or to irrigation by water heavily charged with alkali salts. Here a typical "alkali structure" has developed. A thin crust, in places

coated with white alkali salts, has formed on the surface. Beneath this is a soft granular mulch an inch or two thick, underlying which, in turn, is a somewhat compact and puddled layer. The subsoil is somewhat compacted and contains considerable concentrations and mottlings of alkali salts. This feature also might be considered sufficient ground for a series separation, but such areas are patchy and would be difficult to map consistently.

The Pima soils are similar to those of the Gila series except that they have somewhat darker-brown heavier-textured surface soils. The color difference may be largely coexistent with the heavier texture, but it seems probable that the Pima soils have a somewhat higher content of organic matter. It seems that most of the dark surface soil has been laid down artificially as deposition from muddy irrigation water. Such deposition is taking place every year on the irrigated lands of the area, and the soils are undergoing continual modification. Probably in some places the surface soil was laid down naturally by floods, but there seems to be no reason why a separation should be made on this basis.

In the Gila Bend area the source or character of the parent material has seemingly had comparatively little influence in differentiating the soils from one another, except as to texture. The alluvial deposits of Gila River are of varied origin, containing materials of many kinds, and are, in general, of rather fine texture. The alluvial fans, which have their origin in the surrounding mountains, are of coarser texture, and give rise to stony, gravelly, and sandy soils. Granite and granitic schists are the most common rocks represented. Along the foot of Painted Rock Mountains are stony and gravelly fans in which the material is largely dark basic igneous rock, resembling basalt. The soils developed on these fans are so similar to the Laveen and Pinal soils developed from granitic material that no separation was warranted.

SUMMARY

The Gila Bend area is in the southwest part of Arizona. The town of Gila Bend is about 80 miles southwest of Phoenix and 120 miles east of Yuma. The area includes 224 square miles lying along Gila River, where it makes a large **S** bend around the south end of the rugged Gila Bend Mountains. The area is divided into two physiographic parts by Gillespie Dam—the narrow Gila River bottoms of the Arlington district above the dam and the Gila Bend district which occupies a large open valley below the dam.

Gila River and tributary desert washes provide good drainage for most of the area, though low-lying spots near the river are rather poorly drained and are affected by alkali.

The climate is hot and arid. Rainfall is light, and irrigation is necessary for crop production. The area is sparsely settled.

Five series of soils were mapped in the area, comprising 14 soil types and 2 phases. Three classes of miscellaneous materials are also shown on the soil map. The more mature soils of the area are grouped in the Laveen, Mohave, and Pinal series; the recent-alluvial soils are those of the Gila and Pima series. The miscellaneous nonagricultural materials are river wash, rough stony land, and scab land. The most important agricultural soils are Laveen sandy loam

and Laveen fine sandy loam. Other soils of some agricultural importance are Mohave loam, the Pima soils, and the Gila soils. Pinal gravelly sandy loam and Laveen gravelly sandy loam are of little value.

Agricultural development is limited, as yet, in this area. Only about 15,000 acres were under cultivation in 1927. Development is proceeding slowly but is hampered by an insufficient water supply in midsummer, consequently large areas suitable for agriculture lie idle. Alfalfa hay and seed, cotton, barley, and hegari are the most important crops grown at the present time. Many cattle and sheep are pastured during the winter.

Slight to strong alkali concentrations are found in the Gila and Pima soils. Irrigation waters from wells, as well as those from Gila River, contain a considerable proportion of alkali salts. Little or no black alkali is contained either in the soils or the water of the area.

Land is reasonably cheap, and there is possibility of considerable future development. Dairying might well be carried on more extensively.

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Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the

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(1) mail: U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

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U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
HENRY G. KNIGHT, CHIEF
A. G. McCALL, CHIEF, SOIL INVESTIGATIONS
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP
GILA BEND AREA
ARIZONA

UNIVERSITY OF ARIZONA
AGRICULTURAL EXPERIMENT STATION
E. D. BALL, DIRECTOR
P. S. BURGESS, HEAD, DEPARTMENT OF AGRICULTURAL CHEMISTRY AND SOILS

R. 7 W. | R. 6 W. | R. 5 W | R. 4 W.

T. 1 S. | T. 2 S. | T. 3 S. | T. 4 S. | T. 5 S. | T. 6 S.

LEGEND

- Gila fine sand — G
- Laveen gravelly sandy loam — Ly
- Gila very fine sand — Gd
- Laveen sandy loam — L
- Gila sandy loam — Gy
- Light-textured phase — L
- Gila fine sandy loam — Gf
- Laveen fine sandy loam — Lf
- Hummocky phase — Gf
- Mohave loam — Mm
- Gila very fine sandy loam — Gv
- Pima silty clay loam — Ps
- Gila silt loam — Gm
- Pima silty clay — Pc
- Gila loam — Gl
- Pinal gravelly sandy loam — Pg
- River wash — Rv
- Rough stony land — Rs
- Scab land — S

ALKALI

- Strongly affected — A
- Moderately affected — S
- Free — F

CONVENTIONAL SIGNS

CULTURE
(Printed in black)

- City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort
- Secondary roads and Trails
- Railroads Steam and Electric
- Bridges, Ferry
- R.R. crossings, Tunnel
- Ford, Dam
- School or Church Cemeteries
- Mine or Quarry Mine dumps Made land
- Bluff, Escarpment, Rock outcrop and Triangulation station
- Stony and Gravelly areas
- Soil boundaries
- Boundary lines
- Boundary lines
- Boundary lines
- U.S. township and section lines

RELIEF
(Printed in brown or black)

- Contours Depression contours
- Prominent Hills Mountain Peaks
- Sand, Wash, and Sand dunes
- Shore and Low water line, Sandbar

DRAINAGE
(Printed in blue)

- Streams
- Lakes, Ponds, Intermittent lakes
- Intermittent streams
- Springs, Canals and Ditches, Flumes
- Swamp Salt marshes
- Submerged marsh Tidal flats

The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

Arlington
Gila Ranch
De Nure Ranch
Palo Verde
Theba
Hyder
Sauter
GILA BEND

BUCKEYE HILLS
GILA BEND MOUNTAINS
MARICOPA MOUNTAINS
PAINTED ROCK MTS.

GILA RIVER
HASSAYAMPA RIVER
ARLINGTON CANAL
UNITED STATES CANAL
MAIN CANAL
BRANCH CANAL
GILLESPIE CANAL
HIGH LINE CANAL
GILA VALLEY IRRIGATION DIST. CANAL
HIGHWAY
SOUTHERN PACIFIC COMPANY
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DIAGRAM
Showing location of Area in Maricopa County

Macy H. Lapham, Inspector, District 5.
Soils surveyed by F. O. Youngs, in charge, W. G. Harper, and T. W. Glassey, U. S. Department of Agriculture, and M. R. Isaacson, University of Arizona.

Scale 1 inch - 1 mile
1 ½ 0 1 2 3 4 Miles

WILLIAMS & HEINTZ CO. WASH. D.C.

Field Operations
Bureau of Chemistry and Soils
1928